SFWMD
C-111 Project
Monitoring Plan

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1.0 Introduction

The U.S. Army Corps of Engineers (USACE) has constructed a new pump station, S-332C and three water detention areas on the boundary of Everglades National Park (ENP). These features are part of the C-111 project authorized by the USACE in 1995 to restore more natural hydrologic conditions in the Taylor Slough portion of ENP and to maintain flood protection near Homestead and Florida City.

The construction of these facilities was accelerated to respond to US Fish and Wildlife requirements to give immediate relief to water conditions that threaten the Cape Sable Seaside Sparrow, an endangered species. Construction of S-332C and the new detention areas was completed in June 2002. The USACE signed a Record of Decision on July 2, 2002 that authorizes the implementation of an Interim Operational Plan (IOP) that governs the operation of the new facilities as well as pump stations S-332B and S-332D. On July 31, 2002, the Florida Department of Environmental Protection issued Emergency Order #7 to allow the USACE to operate the new and existing facilities in accordance with the IOP.

The USACE and the South Florida Water Management District (District) will operate the structures and monitor the implementation of the IOP under the terms and conditions of the C-111 Project Cooperation Agreement (PCA) executed in 1995. As local sponsor, the District has agreed to operate and maintain the C-111 Project facilities. The USACE and the District have agreed to jointly develop and implement a monitoring plan that will assess the hydrologic, environmental and water quality changes that may occur as a result of the IOP. This proposal presents the District's recommendation for monitoring that the District would conduct as part of the C-111 Project operations and maintenance.

The monitoring plan is divided into four functional sections:

(1) The permit compliance monitoring portion of the plan focuses on the monitoring of the constructed detention area inflows, outflows, interior surface waters, groundwater, and fish, that should be in an operating permit. The monitoring sites, parameters and frequencies in this section are designed to assure regulators that the project is not discharging surface water or groundwater that does not meet water quality standards.

(2) The standards compliance monitoring portion of the plan focuses on the monitoring of surface water and groundwater downstream of the project and within Everglades National Park. These areas should be monitored to assure continued compliance with applicable water quality standards. The monitoring sites, parameters and frequencies in this section are designed to assure regulators that the project is not adversely affecting downstream conditions.

(3) The ecological response monitoring portion of the plan focuses on the monitoring of surface water, biological components and sediments downstream of the project and within Everglades National Park that should be monitored to document ecological response to the project. The monitoring sites, parameters and frequencies in this section are designed to monitor at an optimum level given the resources available, the ecological response and document habitat improvement or adverse impacts. This section of the plan

takes advantage of existing ecological monitoring projects and may provide the basis for future RECOVER projects in this area.

(4) The surrounding lands monitoring portion of the plan serves as a placeholder for future monitoring of this area. The C-111 project is adjacent to properties that have until recently, been used for agriculture. The future use of these properties is unclear, but once a land management plan is developed, a monitoring plan may be required.

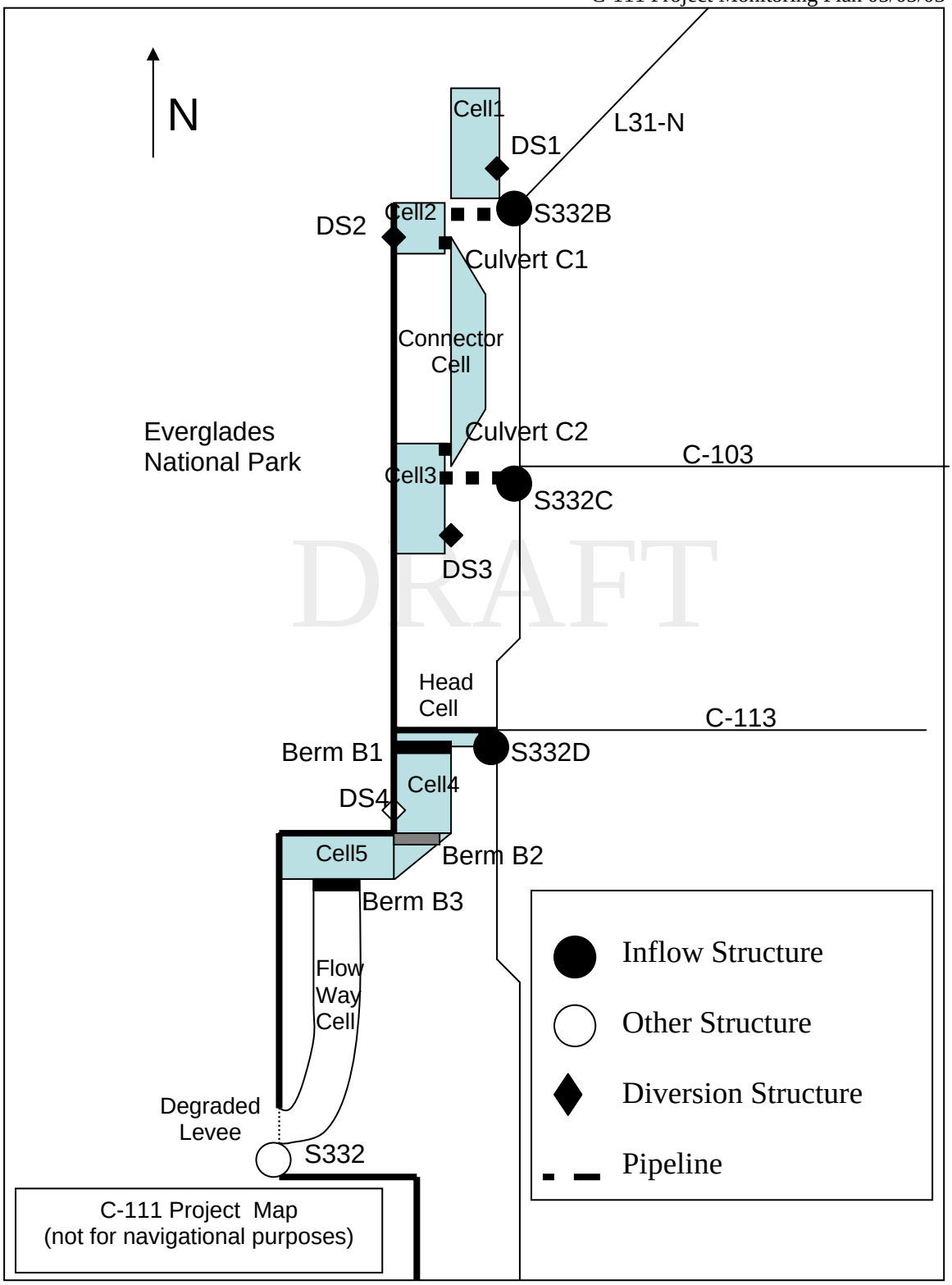
2.0 Permit Compliance Monitoring of Detention Areas

The permit compliance monitoring focuses on the detention area and is designed to provide compliance with a Florida Department of Environmental Protection (FDEP) permit and applicable State and Federal water quality criteria. The monitoring plan provides compliance by quantifying water quality and providing sufficient data to develop a mass balance for constituents of interest. To accomplish these goals the monitoring plan must

1. Measure a water budget for each detention area.
2. Measure concentrations of phosphorus and nitrogen entering and leaving the detention areas.
3. Calculate the loads of phosphorus and nitrogen entering and leaving the detention areas through surface water and groundwater.
4. Measure and evaluate sources of pesticides and other pollutants to and from the detention areas.

A familiarity with the physical structure and features of the detention areas is required to comprehend the monitoring plan. Figure 1 presents a conceptual map of the project with labels for all of the major physical components and structures. These labels are interim designations to facilitate the discussion of monitoring. At the current time, there are two distinct detention areas. The S332D Detention Area is supplied with water from the S332D pump station and is comprised of four distinct cells: Head Cell, Cell 4, Cell 5, and the Flow Way. The Head Cell is separated from Cell 4 by a concrete berm (B1). Cell 4 is separated from Cell 5 by an earthen berm (B2). Cell 5 is separated from the Flow Way by a concrete berm (B3). The Flow Way discharges into ENP through a degraded portion of the L31N levee, however, depending on water levels, water may flow from ENP into the Flow Way. Given the problems with measuring flow at the degraded levee, berm B3 will be used as a surrogate for both flow and nutrient discharges into ENP.

The second detention area has been labeled the S332B Detention Area and S332C Detention Area, which are hydrologically linked. The S332B Detention Area is supplied with water from the S332B pump station and is comprised of two cells. Water from S332B is pumped into either Cell 1 or Cell 2. Water from the Cell 2 may then flow out into the Connector Cell. The Connector Cell then discharges into the Cell 3. Cell 3 and the Connector Cell are also directly supplied with water from the S332C Pump Station. In the future, all the detention areas may be redesigned and linked hydrologically.


N
Cell1
L31-N
DS1
S332B
DS2
Cell2
Culvert C1
Connector
Cell
Everglades
National Park
Culvert C2
C-103
Cell3
S332C
DS3
DRAFT
Head
Cell
C-113
Berm B1
S332D
Cell4
DS4
Cell5
Berm B2
Berm B3
Flow
Way
Cell
Degraded
Levee
S332
Inflow Structure
Other Structure
Diversion Structure
Pipeline
C-111 Project Map
(not for navigational purposes)

In an effort to reduce the repetition of the descriptions of monitoring components, this plan treats the detention areas as a single project with multiple cells, three inflows, a single outflow, and four diversion structures.

Particular interest is paid to hydrologic monitoring. This project is based on the control and management of interactions between surface water and groundwater. Consequently, it would seem necessary to have a thorough understanding of the movement of water in and out of the detention area. Towards this end a water budget must be developed. Additionally, a water budget will provide the necessary basis for the construction of a nutrient budget, which is key to understanding possible impacts to downstream areas.

2.1 Hydrologic Monitoring for Permit Compliance

2.1.1 Surface Water Flows

Surface water flows will be measured at the inflows to the project at S332B, S332C, and S332D. Surface water flows will be measured at the outflow Berm B3. Water flow over the diversion structures (DS1,DS2,DS3 and DS4) will be calculated using staff gauges in each of the cells.

2.1.2 Surface Water Stage

Staff gauges will be installed in all eight cells.

2.1.3 Groundwater Exchange

Seepage from each cell will be estimated by difference.

2.1.4 Meteorological Parameters and Evapotranspiration

Rainfall monitoring sites exist at S174 and S332. Weather stations exist at S331W and in Joe Bay. Evapotranspiration will be calculated using data from these stations. The average evapotranspiration for these two sites will represent evapotranspiration for the detention areas, as will averages for othe meteorological parameters.

2.2 Surface Water Monitoring for Permit Compliance of Detention Areas

The following are the parameters and frequencies to be monitored during routine operations. Additionally, surface water pesticides and mercury data collected by the ACOE must be evaluated to determine if pesticides and mercury need to be sampled at the inflow and outflow sites on a more frequent basis.

2.2.1 Inflows and Outflows of Detention Areas

The three inflows to the project (S332B, S332C, and S332D) and Berm B3 will be monitored as follows:

2.2.1.1 Inflow/Outflow Macronutrients (weekly autosamplers)

Continuous monitoring for TP and TN (calculated from TKN and NOx) using autosamplers set for flow proportional, weekly composite sampling.

Table 2.2.1.1 Parameter list for weekly flow proportional composite autosamplers at the inflow and outflow of the Detention Areas.				
Sampling Type	Number of Sites	Parameter	Frequency	Annual # of Samples
Autosampler	4	Tot P	Weekly	208
	4	Tot N (tkN +NOx)	Weekly	208

2.2.1.2 Inflow/Outflow Nutrients (biweekly grabs)

Biweekly monitoring using grab samples for the following:

Table 2.2.1.2 Parameter list for biweekly grab samples at the inflow and outflow of the Detention Areas.				
Sampling Type	Number of Sites	Parameter	Frequency	Annual # of Samples
In situ	4	D.O.	Biweekly	104
In situ	4	pH	Biweekly	104
In situ	4	Temperature	Biweekly	104
In situ	4	Sp. Conductivity	Biweekly	104
Grab	4	Turbidity	Biweekly	104
Grab	4	Tot P	Biweekly	104
Grab	4	Dis OPO4	Biweekly	104
Grab	4	Dis P	Biweekly	104
Grab	4	Tot NH4	Biweekly	104
Grab	4	Tot kN	Biweekly	104
Grab	4	Tot NOx	Biweekly	104
Grab	4	Dis Cl	Biweekly	104
Grab	4	Tot Susp. Solids	Biweekly	104

2.2.1.3 Inflow/Outflow Metals and Pesticides (quarterly grabs)

On a quarterly basis the biweekly collection will be expanded to include a suite of parameters including mercury, pesticides, ions and metals. Following one to two years of monitoring, this data should be reviewed and reduced where appropriate.

Table 2.2.1.3 Parameter list for quarterly grab samples at the inflow and outflow of the Detention Areas.				
Sampling Type	Number of Sites	Parameter	Frequency	Annual # of Samples
Grab	4	Alkalinity	Quarterly	16
	4	Dis Na	Quarterly	16
	4	Dis K	Quarterly	16
	4	Dis Ca	Quarterly	16
	4	Dis Mg	Quarterly	16
	4	Dis Fe	Quarterly	16
	4	Dis SiO2	Quarterly	16
	4	Dis SO4	Quarterly	16
	4	Dis Cd	Quarterly	16
	4	Dis Cu	Quarterly	16
	4	Dis Zn	Quarterly	16
	4	Dis Solids	Quarterly	16
	4	Dis. Organic C	Quarterly	16
	4	Hardness (calculated)	Quarterly	16
	4	Tot Hg	Quarterly	16
	4	Pesticide Suite	Quarterly	16

2.2.2 Interiors of Detention Areas

Normally, monitoring the transport of nutrients between cells would be relegated to an optimization plan. However, in the case of these detention

areas, monitoring of some parameters has been included in the permit compliance monitoring section. The reasoning behind this was a concern that materials used to construct the detention area levees may themselves be leaching nutrients and other parameters into the water column. Normally, such leaching activity would be detected by monitoring the outflow, but these detention areas do not have conventional outflows, consequently, the interior sites need to be monitored. The sites to be monitored are the culverts between Cell 2 and the Connector Cell (C1), and Cell 3 and the Connector Cell (C2).

2.2.2.1 Interior Waters Nutrients and Mercury (monthly Grabs)

The two surface water sites will be monitored for physical parameters, nutrients and ions on a monthly basis. Additionally, mercury in surface water will be monitored quarterly.

Table 2.2.2.1 Parameter list for monthly grab samples in interior of the Detention Areas.

Sampling Type	Number of Sites	Parameter	Frequency	Annual # of Samples
In situ	2	D.O.	Monthly	24
In situ	2	PH	Monthly	24
In situ	2	Temperature	Monthly	24
In situ	2	Sp. Conductivity	Monthly	24
Grab	2	Turbidity	Monthly	24
Grab	2	Tot P	Monthly	24
Grab	2	Tot OPO4	Monthly	24
Grab	2	Dis P	Monthly	24
Grab	2	Tot NH4	Monthly	24
Grab	2	Tot kN	Monthly	24
Grab	2	Tot NOx	Monthly	24
Grab	2	Dis Cl	Monthly	24
Grab	2	Dis Organic C	Monthly	24
Grab	2	Dis SO4	Monthly	24
Grab	2	Tot Susp Solids	Monthly	24
Grab	2	Tot Hg	Quarterly	8

2.2.2.2 Interior Fish (quarterly)

On a quarterly basis, mosquitofish will be collected from cells 1,2,3,4,5, the Connector Cell, and the Flow Way Cell and will be analyzed in triplicate for THg (21 samples). Additionally, 40 largemouth bass (or other available top predators) will be collected annually from the 8 cells of the project and analyzed for THg, if sufficient quantities are available.

Table 2.2.2.2 Parameter list for sampling of fish interior of the Detention Areas.

Sample Type	Number of Sites	Parameter	Frequency	Annual # of Samples
Mosquitofish	7x3=21	Tot Hg	Quarterly	84
Bass	40	THg	Annually	40

2.2.2.3 Biological and Sediment Monitoring

It is generally agreed that sediment, periphyton, macrophyte and invertebrate monitoring may be key in helping to understand the optimization of the detention areas for possible water treatment.

Such monitoring will be part of any potential PSTA performance plans.

2.2.3 Diversion Structures from Detention Areas

There are four diversion structures in the detention areas, which may be used to overflow out of the detention areas during flood events, or during droughts to move water directly into ENP. These are located on the eastern edge of Cell 1(DS1), on the western edge of Cell 2 (DS2), on the eastern edge Cell 3 (DS3), and on the western edge of Cell 4 (DS4). DS1 and DS3 discharge onto SFWMD properties, which drain into the C-111 canal. DS2 and DS4 discharge into ENP. From a regulatory perspective, only DS2 and DS4 are of concern. In the event that the diversion structures to ENP are necessary, samples for physical parameters, nutrients, ions, pesticides and mercury will be collected once during the event. This data will be compared to inflow data from S332B and S332D.

Table 2.2.3 Parameter list for surface water monitoring at the Diversion Structures.

Sample Type	Number of Sites	Parameter	Frequency	Annual # of Samples
Grab	2	D.O.	1	2
Grab	2	PH	1	2
Grab	2	Temperature	1	2
Grab	2	Sp. Conductivity	1	2
Grab	2	Turbidity	1	2
Grab	2	Tot P	1	2
Grab	2	Tot kN	1	2
Grab	2	Tot NH4	1	2
Grab	2	Tot NOx	1	2
Grab	2	Tot Susp Solids	1	2
Grab	2	Dis Solids	1	2
Grab	2	Tot Organic C	1	2
Grab	2	Dis Organic C	1	2
Grab	2	Dis Cl	1	2
Grab	2	Alkalinity	1	2
Grab	2	Dis SO4	1	2
Grab	2	Tot Hg	1	2
Grab	2	Pesticide Suite	1	2

3.0 Standards Compliance Monitoring of ENP

The standards compliance monitoring portion of the plan focuses on monitoring surface water and groundwater downstream of the project and within Everglades National Park. These areas should be monitored to assure continued compliance with applicable water quality standards. The monitoring sites, parameters and frequencies in this section are designed to assure that the project is not adversely affecting downstream conditions.

This portion of the monitoring plan is not under the aegis of a permit. By not placing this monitoring under the permit, the sampling sites, parameters and regimes can assess conditions and follow an adaptive assessment protocol, as needed. Adaptive assessment will be of particular need after the results from this monitoring are evaluated and modifications for water quality improvement, ecological improvement, or operational changes are required.

3.1 Surface Water Quality Standards

To satisfy the need for compliance with water quality standards, four sites immediately downstream of the Flow Way Cell within ENP will be monitored in a manner similar to the detention areas. Currently there are six sites that are monitored for surface water quality and provide data for the work described in the ecological response portion of this plan.

3.1.1 Standards Compliance Macronutrients (Autosamplers)

Time proportional autosamplers will be used to monitor surface water tri-daily.

Table 3.1.1 Parameter list for weekly flow proportional composite autosamplers at sites immediately downstream of S332D.

Sampling Type	Number of Sites	Parameter	Frequency	Annual # of Samples
Autosampler	6	Tot P	Tri-daily	6500
	6	TotN (TKN +Nox)	Tri-daily	6500

3.1.2 Standards Compliance Nutrients (Monthly Grabs)

The four sites will be monitored monthly using grab samples for the following physical parameters, nutrients and ions:

Table 3.1.2 Parameter list for monthly grab samples at four sites in ENP downstream of the C-111 project.

Sampling Type	Number of Sites	Parameter	Frequency	Annual # of Samples
In situ	4	D.O.	Monthly	48
In situ	4	PH	Monthly	48
In situ	4	Temperature	Monthly	48
In situ	4	Sp. Conductivity	Monthly	48
Grab	4	Turbidity	Monthly	48
Grab	4	Tot P	Monthly	48
Grab	4	Dis OPO4	Monthly	48
Grab	4	Dis P	Monthly	48
Grab	4	Tot NH4	Monthly	48
Grab	4	Tot kN	Monthly	48
Grab	4	Tot NOx	Monthly	48
Grab	4	Dis N	Monthly	48
Grab	4	Dis Cl	Monthly	48
Grab	4	Tot Susp Solids	Monthly	48
Grab	4	Tot Organic C	Monthly	48
Grab	4	Dis Organic P	Quarterly	16
Grab	4	Dis Organic N	Quarterly	16

3.1.3 Standards Compliance Metals and Pesticides (Quarterly Grabs)

On a quarterly basis the monthly collection will be expanded to include the following parameters including mercury, pesticides, ions and metals:

Table 3.1.3 Parameter list for quarterly grab samples at four sites in ENP downstream of the C-111 project.

Sampling Type	Number of Sites	Parameter	Frequency	Annual # of Samples
Grab	4	Alkalinity	4	16
	4	Dis Na	4	16

	4	Dis K	4	16
	4	Dis Ca	4	16
	4	Dis Mg	4	16
	4	Dis Fe	4	16
	4	Dis SiO2	4	16
	4	Dis SO4	4	16
	4	Dis Cd	4	16
	4	Dis Cu	4	16
	4	Dis Zn	4	16
	4	Dis Solids	4	16
	4	Hardness (calculated)	4	16
	4	Tot Hg	4	16
	4	Pesticide Suite	4	16

3.2 Groundwater Standards

Ideally, groundwater monitoring in ENP to observe impacts of the detention area would be integrated with the ecological monitoring downstream of the discharge. However, given the physical layout of the detention areas, the downstream stations are unlikely to see impacts of groundwater influences. Conversely, those areas most likely to see impacts from groundwater are least likely to see impacts from surface waters. Consequently, it is suggested that groundwater wells be located directly west of the detention areas, rather than downstream of the discharge. To accomplish this, a set of twelve wells will be monitored in and around the detention areas. If groundwater monitoring of these wells shows significant inputs from the detention areas, these sites may be expanded to other ecological parameters.

Table 3.2a Ground water monitoring wells
S-332B East Shallow
S-332 B East Deep
S-332B West Shallow
S-332B West Deep
S-332C East Shallow
S-332C East Deep
S-332C West Shallow
S-332C West Deep
S-332D East Shallow
S-332D East Deep
S-332D West Shallow
S-332D West Deep

Table 3.2b Parameter list for ENP groundwater wells.				
Sample Type	Number of Sites	Parameter	Frequency	Annual # of Samples
Groundwater	12	Water Level	Quarterly	28
	12	Odor	Quarterly	28
	12	Color	Quarterly	28
	12	D.O.	Quarterly	28
	12	PH	Quarterly	28
	12	Temperature	Quarterly	28
	12	Sp. Conductivity	Quarterly	28
	12	Turbidity	Quarterly	28

	12	Dis P	Quarterly	28
	12	Dis KN	Quarterly	28
	12	Dis NOx	Quarterly	28
	12	Dis NH4	Quarterly	28
	12	Alkalinity	Quarterly	28
	12	Dis Na	Quarterly	28
	12	Dis K	Quarterly	28
	12	Dis Ca	Quarterly	28
	12	Dis Mg	Quarterly	28
	12	Dis Fe	Quarterly	28
	12	Dis SiO2	Quarterly	28
	12	Dis SO4	Quarterly	28
	12	Dis Cl	Quarterly	28
	12	Dis Solids	Quarterly	28
	12	Pesticide Suite	Semi-annual	24

4.0 Ecological Response Monitoring in ENP

Ecological Monitoring within Taylor Slough in ENP is needed for two purposes. First, the C-111 Project must document that its implementation does not result in adverse ecological impacts downstream of the project. Second, the C-111 Project needs to document the extent to which project implementation is succeeding in meeting its goal of improving the hydrologic and ecological conditions of ENP.

It is proposed that downstream ecological monitoring be conducted as part of the C-111 Project, but outside of the compliance permit. Specifically, it is suggested that the District authorize the continuation of two existing monitoring projects (with minor alterations), so that these programs are incorporated in the C-111 Project (Figure 2).

These projects are: 1) a SFWMD contract with Florida International University (FIU), entitled “Southern Everglades Integrated Monitoring and Science”; and 2) a periphyton monitoring program that was initiated by the SFWMD in 1996 as part of the Biological Monitoring Program for Test 7 of the Experimental Water Deliveries Program.

This plan has the advantage of utilizing a network of established monitoring stations (2 years for FIU sampling of water quality, soils, and plants; 5 years for periphyton monitoring), providing baseline data for comparison with future water quality conditions. Additionally, by incorporating the ecological portions of the existing monitoring, the effects of hydrological and ecological restoration and efficacy of the detention area can be evaluated. Furthermore, since this portion of the C-111 Project monitoring is not under the auspices of a permit, it can be managed to adaptively assess conditions and formulate appropriate responses. It is also suggested that the ENP monitoring be conducted for a period of two years, after which results should be analyzed to assess whether modifications for water quality improvement are required and whether operational changes for ecological improvements should be recommended. Based on these results, and in consultation with RECOVER, a longer term monitoring plan should then be developed.

To satisfy the need to document project success, twelve sites that span hydrologic and water quality gradients within Taylor Slough and that have the maximum amount of baseline information have been chosen. A gradient approach from upstream to downstream (with a set of east-west transects that include short and long hydroperiod

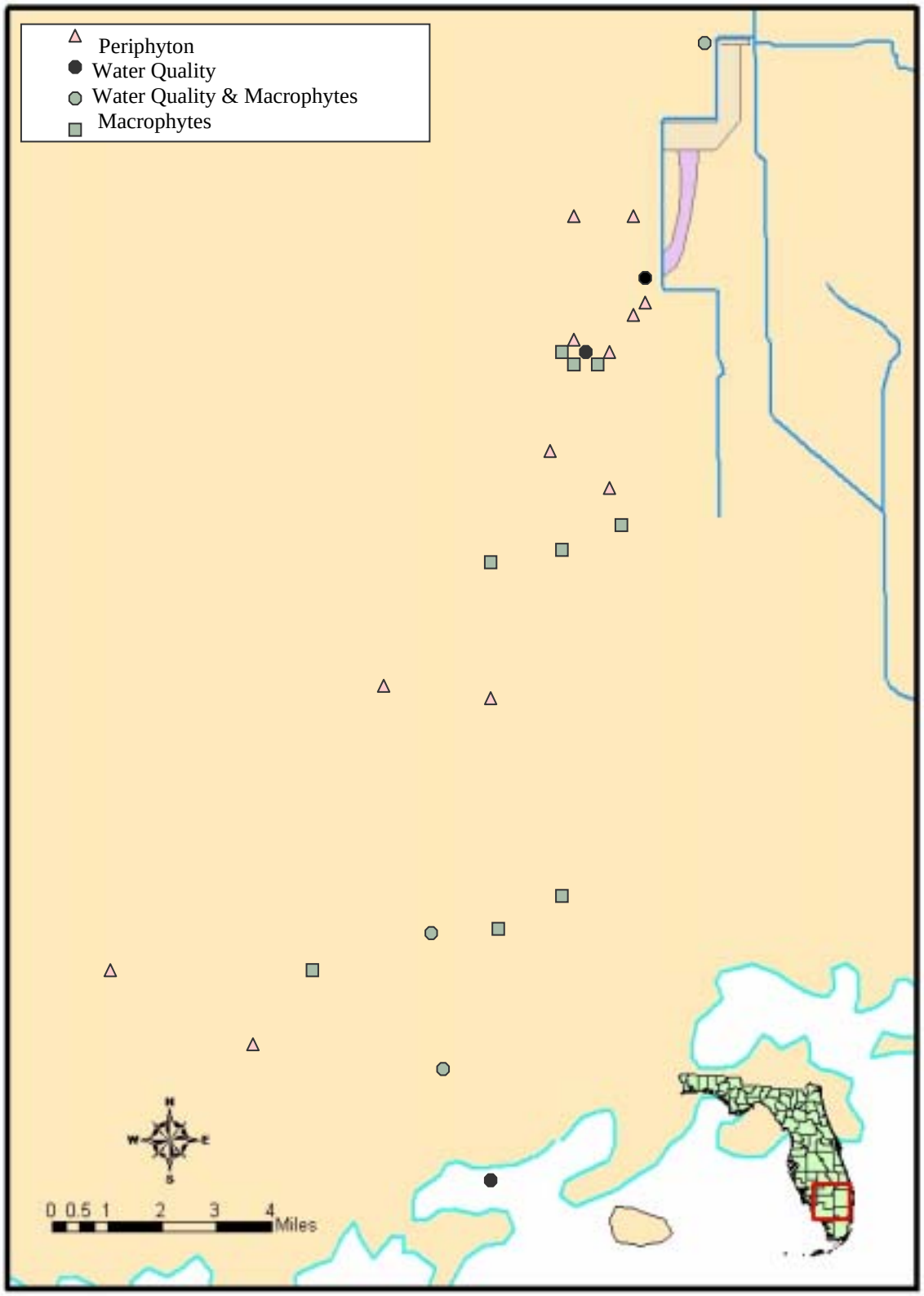
sites) through the northern, central, and southern Slough will enable staff to assess the effects of nutrient inputs from the canal system and assess hydrologic effects via hydropattern and salinity change. Selection of sites with existing baseline information will help staff evaluate the effects of current operations relative to past operations. Downstream ecological monitoring in Taylor Slough will document the status and trends of hydrologic, water quality, and biological components. Water quality monitoring will focus on nutrient status and salinity intrusion in the southern Everglades, while biological monitoring will focus on periphyton and macrophytes, which constitute the base of the food web and habitat structure of Taylor Slough. It is expected that additional information on animal population responses will be available through monitoring efforts of other agencies, such as the National Park Service.

4.1 Ecological Response Monitoring – Periphyton

Periphyton are an essential component of the Everglades food web and can serve as a primary indicator of water quality conditions. Complementary aspects of periphyton ecology have been monitored by SFWMD staff and FIU contractors. The SFWMD has focused on measurement of taxonomic indicators of water quality conditions, using periphytometers (glass slides incubated in the field) and sampling of ambient algal communities. FIU has focused on measuring periphyton growth rates. It is proposed that the monitoring of periphyton continue. It should be noted that the periphyton monitoring project is carried out at sites near to, but not identical, to the water quality sites. This spatial difference is not desirable, but given the period of record at each site and the need to evaluate operational effects of the S332D detention area over the next two years, we consider temporal comparability (pre and post detention area) more important than spatial comparability.

We propose to modify the SFWMD periphyton monitoring network, keeping a set of six east-west transects, but decreasing the number of sites per transect to only two, yielding a decrease in total sites from 28 to 12. FIU's periphyton measurements are done only at three autosampler sites near the S332D flow-way, the mid-slough site (south of the ENP road) and in the salinity transition zone marsh site in the southern slough. The following program is proposed for the next two years, after which a long term monitoring program will be developed in conjunction with the RECOVER Monitoring and Assessment Program (MAP).

C-111 PROJECT ECOLOGICAL RESPONSE MONITORING



4.1.1 Periphytometers

Periphytometers will be used to assess spatial and temporal patterns in periphyton taxonomy on a quarterly basis. One periphytometer (8 slides per periphytometer) will be deployed at each of the twelve SFWMD sites and collected two months later. Samples will be preserved and shipped overnight for taxonomic analysis.

Table 4.1.1 Parameter list for nutrient sampling at perphyton monitoring sites.				
Sampling Type	Number of Sites	Parameter	Frequency	Annual # of Samples
Periphytometer	12	Taxonomy	Quarterly	48

4.1.2 Ambient Periphyton Habitat Characterization.

Periphyton will be collected twice a year at 12 sites from the three common habitats in Taylor Slough (floating mat, benthic mat, and epiphytes) to assess patterns in natural periphyton assemblages. The two sampling events will correspond to early (May-June) and late (Oct-Nov) periods of the wet season. Grab samples will be collected, preserved, and shipped overnight to Florida DEP labs for taxonomic analysis. In addition, a portion of the pre-preserved periphyton sample will be used for tissue nutrient analysis (TP and TKN). This information, combined with dissolved surface water nutrient information, will be used to help interpret trends in taxonomic indicators.

Table 4.1.2 Parameter list for tissue sampling at perphyton monitoring sites.				
Sampling Type	Number of Sites	Parameter	Frequency	Annual # of Samples
Grab	12*3 = 36	Taxonomy	Semi-annually	72
	12*3 = 36	Tot P	Semi-annually	72
	12*3 = 36	Tot kN	Semi-annually	72

4.1.3 Water Samples at Periphyton Sites

In addition to the regular surface water monitoring, grab samples for TKN and TP will be taken at twelve periphyton sampling sites at the beginning and end of quarterly periphytometer deployment (yielding 8 sampling events per year).

Table 4.1.3 Parameter list for nutrient sampling at perphyton monitoring sites.				
Sampling Type	Number of Sites	Parameter	Frequency	Annual # of Samples
Grab	12	Tot P	Semi-quarterly	96
	12	Tot kN	Semi-quarterly	96

4.1.4 In situ diel dissolved oxygen

Hydrolabs will be deployed at six sites on a quarterly basis to assess spatial and diel, patterns in dissolved oxygen, conductivity, pH, temperature and productivity. Deployments will occur prior to periphytometer collection.

4.1.5 Periphyton growth

The daytime productivity and nighttime respiration of periphyton will be estimated by FIU by measuring oxygen changes in light

and dark BOD bottles. These measurements will be made quarterly at three Taylor Slough sites. At the time of each incubation, the organic and inorganic content (ash free dry weight) and nutrient content (C, N, and P) of periphyton tissue will be measured in order to assess growth-nutrient relationships. Estimates from bottle measurements will be extrapolated to ambient field periphyton by measurement of standing stock biomass twice per year at incubation sites. These rates will be compared to estimates of in-situ daytime production and nightime respiration, derived from diel oxygen curves, as measured at six sites by SFWMD.

Table 4.1.5 Parameter list for nutrient sampling at periphyton monitoring sites.

Sampling Type	Number of Sites	Parameter	Frequency	Annual # of Samples
Grab	12*3 = 36	AFDW	Quarterly	144
	12*3 = 36	Tot P	Quarterly	144
	12*3 = 36	Tot N	Quarterly	144
	12*3=36	Tot C	Quarterly	144

4.2 Ecological Response Monitoring – Macrophytes and Sediments

Macrophytes and sediments are an essential component of the Everglades food web and can serve as integrative indicators of long-term environmental conditions. Improved macrophyte habitat is a goal of hydrologic restoration. Complementary aspects of macrophyte ecology have been monitored by SFWMD staff and FIU contractors. It is proposed that monitoring macrophytes and sediments continue. The following program is proposed for the next two years, after which the data will be analyzed and a long term monitoring program developed in conjunction with the RECOVER MAP.

4.2.1 Macrophytes

Macrophyte species composition, spikerush and sawgrass density, above-ground biomass, and net productivity will be estimated bimonthly, non-destructively. Nutrient (C:N:P) ratios in plant tissues, an integrated indicator of nutrient status, will be measured annually.

Table 4.2.1 Parameter list for sampling at macrophyte monitoring sites.

Sampling Type	Number of Sites	Parameter	Frequency	Annual # of Samples
Non-destructive	12*3=36	Speciation	Bi-monthly	216
Non-destructive	12*3=36	Biomass	Bi-monthly	216
Non-destructive	12*3=36	Productivity	Bi-monthly	216
Grab	12*2*2=48	Tot C	annually	48
Grab	12*2*2=48	Tot P	annually	48
Grab	12*2*2=48	Tot N	annually	48
Grab	12*2*2=48	Dry weight	annually	48
Destructive	12*3=36	Above Ground Biomass	annual	36
Destructive	12*3=36	Below Ground Biomass	annual	36

4.2.2 Soils and Porewater

The following soil parameters will be monitored in triplicate at all vegetation sites for basic nutrients and physical parameters. Porewater nutrients and salinity will be measured in duplicate at depth of the

rootzone (a 5 cm horizon at 15 cm depth) at 12 sites, semi-annually. Additionally, pesticides and mercury will be measured in soils at four sites where water quality is sampled by autosampler.

Table 4.2.2 Parameter list for sampling at soil monitoring sites.				
Sampling Type	Number of Sites	Parameter	Frequency	Annual # of Samples
Grab	12*3=36	Tot C	Annually	36
Grab	12*3=36	Tot P	Annually	36
Grab	12*3=36	Tot N	Annually	36
Grab	12*3=36	Bulk density	Annually	36
Grab	12*3=36	%Organic	Annually	36
Grab	4	Tot Hg	Annually	4
Grab	4	Pesticides	Annually	4
Porewater	12*2=24	Salinity	Semiannually	48
Porewater	12*2=24	Sol Reactive P	Semiannually	48
Porewater	12*2=24	Dis Inorganic N	Semiannually	48

4.2.3 Water Samples at Macrophyte Sites

Monitoring nutrients within Taylor Slough provides information on nutrient transport from canal sources and effects within the wetland. Such information is also required in order to understand how biological changes relate to hydrological and water quality modifications of the Slough. Water quality will be analyzed by a combination of routine autosampling for TN and TP at a subset of six stations and monthly to quarterly grab samples at all stations. This section duplicates work described in section 3.1.

5.0 Monitoring of Surrounding Lands

It is recommended that an ecological monitoring plan be developed for the lands on the eastern borders of the detention areas. The lands immediately to the east of the detention areas have been leased on an interim basis. Much of the land continues to be leased and is managed for the District by the South Dade Soil and Water Conservation District (SDSWCD). The SDSWCD uses lease revenues to do some water quality monitoring and to keep exotic plant infestations under control. These management plans will need to be modified as a result of the new facilities and the changes in operational regimes. However, to date the SFWMD has not created a land management plan for these areas and has not designated their future use. Once such guidance is developed, a monitoring plan for these areas will be integrated into this plan. At a minimum, groundwater wells for monitoring groundwater levels and future monitoring of groundwater quality will be installed.

5.1 Surrounding Lands Groundwater (quarterly)

The surrounding lands will have at least eight sets of two wells (2” wells with 5 feet of screen at depths of 15 and 30 feet) for a total of sixteen wells. Wells will be designed for both level and water chemistry monitoring.

6.0 Quality Assurance

None of the preceding estimates of the number of samples include quality assurance (QA) samples. QA requirements vary by project, matrix, and analysis and will be developed on a case by case basis. For budgeting purposes, it is suggested that 30% be added to the sample load to account for QA costs. A QA plan will be developed to meet minimum criteria for compliance with National Environmental Laboratory Accreditation Conference (NELAC) standards, as well as with FDEP standard operating procedures. This plan will also include laboratory participation in standard quality evaluations, such as round-robins and split sample analysis.

Appendix 1 Budget and Funding

The budget and funding of these monitoring plans is complex but critical to the success of this project. For funding purposes, the project can be broken up into multiple parts. Table A1 summarizes the cost estimates for each of these parts. Technical labor costs were minimized by using governmental contractors.

A1.1 Permit Compliance Monitoring

Monitoring associated with the inflows and outflows as well as the interior of the detention areas was split between two agencies. Dade County DERM will monitor water, while the Florida FWCC will monitor fish. Analysis will be carried out by the SFWMD laboratory. Annual costs for this portion are $262,000.

A1.2 Standards Compliance Monitoring of Groundwater

Funding for the collection of groundwater sites for the C-111 project for compliance with state water quality standards will be carried out under an agreement with ENP. Analysis will be carried out by the SFWMD laboratory. Annual costs for this portion are $102,000.

A1.3 Standards Compliance Monitoring of Surface Water

Funding for the collection of groundwater sites for the C-111 project for compliance with state water quality standards will be carried out under an agreement with FIU under the Ecological Response Monitoring section.

A1.3 Ecological Response Monitoring – Water, Periphyton, Macrophytes and Sediment

Monitoring associated with sites in ENP for ecological responses of Taylor Slough will be carried out under an existing contract with FIU. Analysis will be carried out by the SFWMD laboratory and FIU laboratory. Annual costs for this portion are $252,000.

A1.5 Surrounding Lands

Monitoring associated with sites in the surrounding lands have no funding at this point.

A1.6 Management Staff

Estimates suggest that managing this project will require a project manager at a cost of $70,000.

Table A1 Annual Project Summary Costs

Project	Analysis	Supplies	Tech Staff	QA	Report	Manage ment	Total Annua

						Staff	l
Permit	$62K	$5K	$146.5K	$18.5K	$30K	$70K	$332K
Standards (GW)	$51.5K	$5K	$20K	$15.5K	$10K		$102K
Surrounding Lands				$8K	$8K		$16K
Ecoresponse	$68K	$5K	$175K	$2K	$2K		$252K
Totals	$181.5K	$15K	341.5	$44K	$50K	$70K	$702K

A1.7 Summary

Annual costs for this project are estimated at $702,000 and an additional first year cost of $20,000 for capital equipment. First year costs will be $724,000. The SFWMD has budgeted a $704,000 for this project.